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ABSTRACT

A change in philosophy for pharmacology instruction for paramedical students required a change to non-traditional methods of instruction. The course consists of five specific and one student-designed unit including objectives, study questions, projects, quizzes, and exams. Multimedia support is discussed, as well as the use of unit directions, study questions, and course projects. Interfacing with the library is essential and methods are explained. Exams are criterion referenced: 85% mastery is required. Final exams are patient-drug case studies, testing ability to apply material mastered. Results indicate a positive change in student attitudes and grade statistics. (Author/VT)

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MASTERY-BASE PERSONALIZED INSTRUCTION IN PHARMACOLOGY

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Mastery-base personalized instruction in pharmacology

A change in philosophy for Pharmacology for Paramedical students at Indiana University - Purdue University at Fort Wayne has required a change to non-traditional methods of instruction. Lecture notes are distributed freeing class time for problem solving and logical integration of facts. The course consists of five specific and one student-designed unit including objectives, study questions, projects, quizzes, and exams. Exams are criterion referenced; 85% mastery is required. Final exams are patient-drug case studies testing ability to apply material mastered. Despite greater work load, grades are significantly higher. Student evaluation is overwhelmingly positive. Library support is critical to the success of the program.

INTRODUCTION

As I began to think about the traditional grading system as applied to pharmacology taught to nursing students, I began to seriously question its validity. Norm-referenced exam results told the students (and the instructor) that they knew more than, as much as, or less than their average classmate. Their grade seemed only incidentally to reflect the amount of usable knowledge of pharmacology they had acquired. Further, I was not at all sure that I wanted a student with even a C under that system, much less a D, responsible for my medication were I to be hospitalized. In addition, a student with an A who could not apply to actual situations the facts acquired seemed almost as undesirable. Considering this, I realized that the time factor in the traditional approach was also no longer valid assurance that the material was mastered regardless of when that mastery took place was critical. I decided some changes were in order.

The course had been given in the traditional manner in the spring of 1972 and 1973 to classes of 220 nursing students, Licensed Practical Nurses, and Licensed Practical Nurse students, all of whom would be directly responsible for medication in the clinical situation. It was also given in the summer of 1972 to sixteen students with the same career objectives. By spring of 1973 the course had also become an elective for respiratory therapy, emergency medical technology, and medical technology students. These students have entirely different reasons for taking the course and will use the information obtained in different clinical situations and to make different types of decisions. The course format needed the flexibility to reflect these needs. The summer of 1973 class of twenty-one students has career objectives which reflected the addition of other than nursing students.

The change in philosophy and, consequently, in format was made for the summer 1973 class, and the comparison of results made here is between the two summer classes - 1972 and 1973.

CHANGES THAT MOVED TOWARD A MASTERY BASE AND PERSONALIZED INSTRUCTION

A New Look at Course Objectives:

The challenge of these realizations led to a reevaluation and a restatement of course objectives, and the sharing of these objectives with the students.

They are:

1. To require and adequately evaluate student mastery of a required body of factual material in each of the following areas:
 - a. principles of drug action
 - b. central nervous system drugs
 - c. autonomic nervous system drugs
 - d. diuretics
 - e. cardiovascular drugs
 - f. anti-infective agents
 - g. cancer chemotherapy
2. To provide the student with unit objectives, a list of tasks to be performed, lecture notes, and study questions so that he knows what material he must master and can evaluate his progress pre-exam.
3. To require and adequately evaluate student ability to apply facts to:
 - a. material and clinical situations related to each unit
 - b. drugs related to a specific patient
 - c. drugs related to other drugs
 - d. material encountered in areas not specified in Objective 1.

4. To require and adequately evaluate student ability to use primary reference materials in pharmacology and to assess validity of information obtained.
5. To provide lecture-discussions of material and guided discussions leading to the application of facts.
6. To provide a flexible scheduling to allow each student to proceed, within limits prescribed by the university, at a more individualized pace.
7. To place emphasis on learning the material, not on relative quality, by:
 - a. requiring a student to correct errors and resubmit work error free and granting all points possible of any assignment at this point (exams and quiz scores excepted)
 - b. allowing one retake of each exam or quiz to attain mastery
 - c. requiring student-instructor conference when either A or B is not achieved.

Course Format:

A traditional unit breakdown of the course was maintained. Principles, central nervous system and its drugs, autonomic nervous system and its drugs, diuretics, cardiovascular disease management, anti-infective agents, and cancer chemotherapy are covered in that order. In order to fulfill objective 3d, an eighth unit must be chosen by the student covering an area of unique interest. This allows a non-nursing student to investigate drugs in the areas in which they will be encountered. It also allows nursing students to investigate a particular area, since many have already decided on a field of specialization. This unit must be researched by the student and include behavioral objectives (part of the criterion against which the rest of the work is evaluated), tasks

performed, bibliography, and research report. The specified units also require some library work, and the student's grade objective specifies the amount.

Printed Lecture Notes:

If students were to be freed to learn to apply material, they needed classroom time to deal with material in discussion and explanation. I had a well-prepared set of overhead transparencies which I used in the traditional course from which to lecture. In the class time, students would frantically copy this material verbatim missing the discussion and explanation in the effort to "take notes." Further, I had to make sure I "gave" them all the material they needed which severely limited the time available for discussion and learning to apply the theory to the problems. Pharmacology is not a theoretical science: students must learn how to use the information in a clinical situation. Student questions are vital to this process, presenting situations where they have encountered a problem with understanding or application or simply clarification of the situation under consideration. Time and freedom for this was virtually nonexistent.

The solution was simple - type onto paper material on the overhead transparencies, duplicate it and put it in the hands of the student at the beginning of the course. (An example can be found in Figure 1.) This freed classroom time to explain the material and discuss its applications and freed the students' time to make notes on the explanation and the discussion. Student questions are abundant and dealt with easily without losing the train of the material presented; eyes are up out of the notebook much of the time; minds (reflected in comments and questions) are dealing with the material as it is presented.

Unit Directions Sheet and Study Questions:

So that the student knows exactly what will be expected of him in each

unit, eliminating as far as possible the guess work which often distinguishes one student's grade from another, a directions sheet (see Figure 2a and b) is included with the class notes. This lists first of all the behavioral objectives for the unit, and secondly, the tasks which must be completed in the unit. A bibliography is provided in terms of primary reference materials. Students may elect to purchase a text book, also, to provide background reading on each of the topics covered in the course. Most students do purchase the text. Also listed are projects (or problems) which a student can choose to research and solve. *** These projects may take any form but are usually one to two typed pages, report format.

The unit directions sheet specify drug cards to be completed for the unit, if the student is in a nursing field. These are divided into two types: classification and subclassification cards which must give mode of action, therapeutic effect, clinical uses, side effects, toxicities, and contraindications and cautions (nursing faculty have the students add nursing implications); and individual drug cards which must give the class of the drug, primary and secondary clinical uses, any unique information not given on the class card, and dose form and range. Students not in the nursing field may choose to do

*** Examples of these projects are: Principles Unit - read Psychology Today, V. 5 #4 September 1971, p. 16 and V. 5 #12 May 1971, p. 31 and react, browse Remington's Pharmaceutical Sciences, 14th Edition, to ascertain the depth and diversity of material involved in pharmaceutical sciences; Central Nervous System Unit - compare descriptions of APC's Phenaphen^R, and Darvon^R in AMA Drug Evaluation and the Physicians Desk Reference and draw appropriate conclusions. evaluate the question "Are over-the-counter sleeping medications effective?"; Autonomic Nervous System Unit - using Hazards of Medication and AMA Drug Evaluations, investigate the sympathomimetic amines for use in over-the-counter medications; Diuretic and Cardiovascular Unit - Treatment of peripheral vascular disease, Items and Drugs found on Hospital Emergency Carts and Why?; Antiinfective and Antineoplastic Unit - read the unit in Drugs of Choice on cancer and its chemical treatment and respond, respond to the question "How effective are the over-the-counter topical antibacterials?" and recommend the best agent to a mother of young children.

the assigned drug cards or choose to do research on drugs that will be met specifically in their career, giving the same information on these.

Both the drug cards and the unit projects require that a student use the library, and specifically primary reference materials in pharmacology. This work is designed specifically to fulfill the course objective requiring that a student be able to apply facts to material and clinical situations related to those facts.

Study questions (Figure 3) written from the objectives, the lecture notes, and from the exams themselves allow the student to test mastery of the material before taking the exam itself. Since emphasis is placed on ultimate mastery of a certain body of material it is important that there be some way for the student to gauge progress. Knowing where the gaps in knowledge are before the exam allows the student to restudy, seek help, or do additional reading in these areas and thus achieve that mastery with minimal need for later remedial work, or retake exams. The study questions also provide the means for narrowing and pointing out the material considered essential from that which is illustrative or supportive. In a field as broad as pharmacology this narrowing is essential; if mastery is to be expected it cannot be left to the guess work of the student.

EXAMINATIONS:

As has been mentioned before, all exams are criterion referenced; that is, questions are designed to test material covered, not to differentiate students into grade categories. Ideally then questions are written so that every student, if he had adequately learned the material, is able to answer each one correctly. Thus, students' scores indicate how much material they have mastered. The criterion becomes the total amount of material defined in the objectives as necessary for a student to perform at a desired level of competence in a clinical situation. "Trick" questions and questions which are designed merely to sort out the "better student" must be avoided; however, in most

other respects the criterion referenced exam looks like the norm-referenced one. The difference lies in the objectives for writing the exam and in the validation against which each question is tested.

At least three different dates are available for a student to take any exam or quiz, allowing some leeway for individual pacing. In addition, two take-home final exams are administered. One consists of clinical problems listing a diagnosis for a patient and drugs administered. The student must give the classification of the drug, its use for that patient, and the relationship to other drugs given that patient. The other is a six page research report to be done on a particular patient of the student's choosing and the drugs prescribed. This must cover in depth the same type material as the assigned clinical problems. Patients with whom the student has had to deal in other courses or in the clinical situation are encouraged, e.g. nursing care studies, or ones in the student's particular area of interest, e.g. pediatrics. The final exams are designed not to test memory or ability to cram but use of material covered in the course and the student's ability to find in primary reference materials the answers to the problems that must be solved. In a clinical situation memorization of facts is useless unless they can be applied. Further, it is impossible to memorize all one needs to know to administer all drugs safely: a knowledge of what primary reference to go to for the information is essential.

Evaluation of Student Performance:

Evaluation of all non-classroom exam material is either "all or none", that is either the student's work meets acceptable standards and receives full credit for it, or it is returned for correction and resubmission. The minimal standards the work must meet are: 1) no factual or interpretive errors, 2) meets all stated objectives, and 3) covers the field chosen adequately; that

is, no information omitted. If on resubmission the work is still unsatisfactory the student must meet in conference with the instructor to determine where the problem lies and what remedial action must be taken. This procedure allows valuable work to be assigned without the problem of establishing a relative point score on the basis of subjective evaluation of quality above minimum standards. It also allows a student the valuable experience of doing the work correctly; again at what point the learning occurs is really immaterial as long as it does occur.

Exams, however, are graded on points correct and the actual score is recorded. Seventy (70) per cent of the points possible for a unit is the minimal acceptable score for the unit. Any unit score below that requires that all or part of that unit be retaken: one or more unacceptable unit scores at the end of the course constitutes a grade of Incomplete. Thus a course grade of C means that a student has met the minimum performance standards on course objectives and knows a satisfactory amount of pharmacology to function adequately in a clinical situation.

Mastery of unit material is set at eighty-five (85) per cent. All students are encouraged to strive for mastery; those who do not achieve it and elect to take a C for the course must make up the point differential between their score and the points required for mastery by doing one or more unit projects. Mastery must be obtained on each unit for a course grade of A or B. If a student misses mastery by greater than five points on a unit, retake of all or part of the unit is encouraged. If at that point a student still lacks mastery or an acceptable score, a conference with the instructor is mandatory to determine where the problem lies and to prescribe remedial work before any more testing is permitted. Upon completion of that work, a second conference followed by further testing to assess the student's progress is made. If a

student misses mastery by five points or less, two options are open: scheduling a retake on all or part of the unit, or setting up a conference with the instructor during which an oral exam of the information missed can be used to prove mastery of the material.

Course grades are assigned on the basis of points accumulated (Figure 4), so that at any time during the course the student knows exactly what is left to do to achieve the grade of choice. A C reflects the number of points necessary for mastery plus the required course work. A or B reflects the number of points for mastery, the required course work, and the number of unit projects completed, each project being worth twenty-five points. Thus, the A or B reflects a student's increased interest, willingness to spend time learning, and broadened knowledge of the application of material beyond the minimum required.

Cooperation of the Library:

The library is playing a major role in the redesigning of the course. Selective purchasing of materials in pharmacology was done out of both departmental and reference funds. These materials were placed on Reserve for students use and each student is provided a list of these materials. This makes possible the designing of the course to give the students the problem and make them hunt for the solution. They can be required to find and sort the information, learning to recognize valid material while rejecting inferior sources. This they must compile in precise form; the process (drug cards, projects, final exams, student designed units) becomes automatic by repetition. At first the instructor in class must provide considerable guidance through explanation and discussion, but as the course proceeds, less and less direction is neither needed nor desirable.

In preparation for the course, the library staff has undertaken orientation of all pharmacology students to its services. In groups of ten they receive a three part orientation: 1) a general slide/tape presentation showing the physical aspects of the library as well as brief instruction on the use of such resources as the card catalog, indexes to periodicals, reference books and circulating books, newspaper indexes, pamphlet file, and governmental publications 2) a three page guide to the use of the library (What You Have Always Wanted to Know About the Library - But Were Afraid to Ask) 3) a bibliographic tour which indicates materials on Reserve, use and location of the card catalog, periodical indexes, and reference books and circulating books in their subject area. A five question quiz (see Figure 5) is distributed at the end of the tour. The first question asks the student to locate a book in his subject area or major and list it by author, title and complete call number to show the understanding and the use of the card catalog. The second question tests the knowledge and use of periodical indexes in the student's subject area to locate a magazine article on a subject of interest. Write complete information: author, title of article, name of magazine, volume, issue, date, pages, and which index was used. The third question: to list a Reference book in the subject giving the author, title, and call number acquaints the student with reference materials. The fourth and fifth questions: to locate the floors of the library on which periodicals and circulating books in the subject areas are found. This familiarizes them with the physical aspects of the library.

RESULTS AND DISCUSSION

Have there been any significant results of this change in philosophy and resulting changes in course format? Conferences with the nursing faculties of the school involved indicate that in fact the students do know pharmacology and

can use it in the clinical situation more adequately if they have taken the restructured course rather than the traditional one. One emergency medical technology student commented that he made three correct decisions in one week concerning the involvement of medications in the emergency because he had worked with the drugs enough on his own in the course to be able to quickly repeat the thought process in the emergency.

Student evaluations in the traditional program have along indicated the need for a course so restructured, with 75% of the students answering "no" to the questions, "I feel I can apply the theory learned to a clinical situation," and "I feel I had sufficient freedom to choose topics which will be important to me in my career." The same questions for the restructured course elicited only one negative response. Other questions asked students in course evaluation under the new methods and the per cent positive responses were given here (Percentages are of the 21 students completing the course):

1. Were the course notes valuable? 100%
2. Were the unit directions valuable? 95%
3. Could you have done as well without the study questions? 10%
4. Did you use the retake option for exams or quizzes . . .

not at all	40%
once	20%
twice	30%
three times	20%
more than three times	10%
5. Even with retake privilege on how many units did you fail to make mastery?

none	85%
one	10%
more than one	5%

6. I feel that mastery defined at 85% is unfair. 10%
7. I would prefer a traditional testing procedure. 0%
8. I felt the two final exams were of more value than the traditional cumulative final exam. 95%
9. I learned valuable skills and information from the unit projects. 95%
10. I would have learned more from the traditional lecture type course. 0%
11. The library services and resources were adequate for the needs of the course. 100%
12. Given the freedom to take exams on any one of several dates I tended to procrastinate. 60%
13. Realizing that the traditional method would be less work, I vote for the keeping of the new method. 100%
14. I received the grade I set as my goal at the beginning of the course. 85%
15. How many hours per week did you spend on pharmacology on the average?

less than 4	5%
4-6	10%
6-8	70%
more than 8	15%

Perhaps the most significant result, however, is the grade statistics. Comparing the two courses of similar student composition and size, the drop rate and the rate receiving incompletes are comparable; the number receiving A or B is significantly higher in the restructured course even though the requirements for the attainment of those grades is also significantly higher. (See Tables 1 and 2.) In the traditional summer 1972 class 61% of the students received either an A or B, while in the restructured summer of 1973 class 75% of the students received either an A or B.

Thus it seems that both in terms of professional and student response and in terms of performance as reflected in the grade the results of the change in format and philosophy have been significant. In terms of my own feelings which started the whole process in the beginning - anyone who gets a C in the new course I would be glad to trust with my medication were I to be hospitalized.

TABLE 1

Course Statistics	Summer 1972	Summer 1973
Total number of students	16	21
Number of students completing course	12	15
Number of students erasing Incomplete	1	1
Number of A's	5	8
Number of B's	3	4
Number of C's	5	4
Drops after two weeks	3	0
Incompletes	0	5

TABLE 2

Percentage of students completing
the course to receive grade.

	Summer 1972	Summer 1973
A	38	50
B	23	25
C	38	25

DRUG CARDS

CLASSES

SUBCLASSES

DIURETICS

4

DIGITALIS

0

ANTIARRHYTHMICS

2

ANTICOAGULANTS

2

CORONARY VASODILATORS

2

VASOPRESSORS

0

STIMULANTS

0

FIGURE 1 - AN EXAMPLE OF THE FORMAT FOR THE COURSE NOTES EACH STUDENT
IS REQUIRED TO PURCHASE

DIGITALIS OVERDOSE CAUSES

1. EXCESSIVE SLOWING
2. VARIETY OF ARRHYTHMIAS IN VENTRICAL TACHYCARDIA
3. ATRIAL IMPULSE BLOCK (REVERSED BY ISOPROTERENOL)
4. COUPLED BEATS -- FATAL VENTRICULAR FIBRILATION

STOP MEDICATION IF APICAL PULSE IS LESS THAN 60 BEATS/MIN.

SYMPTOMS INCLUDE

HEADACHE

NAUSEA

ANOREXIA

1ST STAGE

VOMITING (NO DRUG COUNTERACTS)

ABDOMINAL PAIN 2ND STAGE

DIARRHEA

CARDIAC MALFUNCTION 3RD STAGE

NAUSEA FROM GI IRRITATION/VOMITING FORM BRAIN BLOOD LEVELS

FIGURE 2 - AN EXAMPLE OF THE UNIT DIRECTIONS SHEET

UNIT FOUR

OBJECTIVES

1. TO INVESTIGATE KIDNEY FUNCTION AND THE MODE OF ACTION AND CLINICAL USES OF DIURETICS.
2. TO INVESTIGATE THE MECHANISM OF COAGULATION AND THE MODE OF ACTION, CLINICAL USES, AND ANTIDOTES FOR ANTICOAGULANTS.
3. TO STUDY THE NORMAL CARDIAC ACTION AND IDENTIFY ERRORS IN CARDIAC FUNCTION.
4. TO INVESTIGATE THE DRUGS USED TO CORRECT CARDIAC MALFUNCTION AND TO MAINTAIN NORMAL FUNCTION.
5. TO STUDY THE TOTAL DRUG MANAGEMENT OF A DISEASE PROCESS - MYOCARDIAL INFARCT.
6. TO STUDY BRIEFLY THE MANAGEMENT OF HYPERTENSION.

TASKS

1. READING ASSIGNMENT
2. DRUG CARDS
3. DIURETIC QUIZ 30; CV DRUGS QUIZ 10; CV SYSTEM QUIZ 10; EXAM 40
4. PROJECT WORK AS DESIRED

READING ASSIGNMENT

TEXT

FACTS AND COMPARISONS, UNIT 4

PHARMINDEX SEPT. 72-3, OCT. 72-5, APR. 71-4, MAY 71-4, MAY 73-4

DRUGS OF CHOICE, PP. 343-430, 594-605, 85-97

AMA DRUG EVALUATIONS, CH. 1,2,3,4,5,6,7,9

PROJECTS

1. PERIPHERAL VASCULAR DISEASE
2. HYPERTENSION - CAUSES AND CURES, CONTRAINDICATIONS
3. THE EMERGENCY CART AND ITS CONTENTS
4. EMERGENCY DRUG AID FOR THE CARDIAC VICTIM
5. "WATER PILLS" OVER THE COUNTER
6. CHOLESTEROL; DIET AND DRUG MANAGEMENT OF ARTERIOSCLEROSIS

FIGURE 3 - an example of the study questions

Unit 4

Study Questions - Diuretics

1. a. What are the three functions of the normal kidney?
b. When a malfunction of each occurs what is the physiological result?
2. Diuretics are only useful under what physiological conditions?
3. Why are diuretics useful in treating
 - a. poisoning
 - b. nitrogen build up
 - c. hypertension
4. How do diuretics relieve edema?
5. What is the specific mode of action of diuretics?
6. What are the three therapeutic effects?
7. What is the clinical result?
8. What conditions can this clinical result be used to treat?
9. a. What are three common side effects of diuretics?
b. What class of diuretics is most likely to cause each one?
c. How is each treated?
10. What drug classes are used in emergency
11. When are the sulfonamide diuretics contraindicated?
12. What class of drugs do diuretics potentiate?
13. With what class of drugs is there a cross-allergic response to the sulfonamide diuretics?
14. What is the single most common diuretic agent?
15. What is the "fad" prescription diuretic in Fort Wayne?
16. a. What class of diuretics has the same mode of action as digitalis?
b. What is the mode of action?
c. What are the two over-the-counter agents of this class?

FIGURE 4 - OUTLINE FOR POINTS REQUIREMENTS TO ASSIGNMENT OF COURSE GRADE.

- 1. MASTERY OF FACTS 85% (408 EXAM POINTS)**
- 2. MINIMUM ACCEPTABLE 70% (336 EXAM POINTS)**

UNIT 1	100 PTS.
UNIT 2	150 PTS.
UNIT 3	30 PTS.
UNIT 4	100 PTS.
UNIT 5	100 PTS.

1 COMPLETE MODULE	100 PTS.
5 CLINICAL PROBLEMS	125 PTS. (25 EACH)
1 FINAL EXAM	150 PTS.
DRUG CARDS	125 PTS.

- 3. REQUIRED WORK 500 PTS.**

C GRADE: POINTS OVER 336 MAY BE OBTAINED THROUGH PROJECT POINTS

B AND A GRADE: BASED ON LEARNING AND APPLICATION BEYOND MASTERY OF FACTS. 408 EXAM POINTS MUST BE OBTAINED

EACH PROJECT OR PAPER (SPECIFIED IN UNIT) 25 PTS.

- 4. MINIMUM FOR C 900 PTS.**
- 5. MINIMUM FOR B 1050 PTS.**
- 6. MINIMUM FOR A 1175 PTS.**

FIGURE 5 - THE QUIZ GIVEN TO ASCERTAIN THE ADEQUACY OF A STUDENT'S PREPARATION TO USE THE LIBRARY.

1. IN THE CARD CATALOG LOCATE A BOOK IN YOUR SUBJECT OR MAJOR AREA AND LIST AUTHOR, TITLE AND COMPLETE CALL NUMBER.
2. IN YOUR SUBJECT INDEX LOCATE A MAGAZINE* ARTICLE ON A SUBJECT OF INTEREST TO YOU. WRITE COMPLETE INFORMATION: AUTHOR, TITLE OF ARTICLE, NAME OF MAGAZINE, VOLUME, ISSUE, DATE, PAGES, AND WHICH INDEX YOU USED.
3. LIST A REFERENCE BOOK IN YOUR SUBJECT: AUTHOR, TITLE, AND CALL NUMBER.
4. ON WHAT FLOOR OF THE LIBRARY ARE THE BOOKS IN YOUR SUBJECT AREA LOCATED?
5. WHERE ARE THE MAGAZINES IN YOUR SUBJECT AREA LOCATED? GIVE FLOOR AND CALL LETTERS.

* MAGAZINE, PERIODICAL, JOURNAL OR SERIAL ARE USED SYNONYMOUSLY IN THIS LIBRARY.

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